

FINAL
IN-45-CR
OCIT
64179
P-4

Final Technical Report

to

Office of Mission to Planet Earth
National Aeronautics and Space Administration
Washington, D.C.

from

The Woods Hole Research Center
Woods Hole, Massachusetts

August 28, 1995

Grant Number: NAGW-2725

Title of grant: "The Role of Tropical Deforestation in the Global Carbon Cycle:
Spatial and Temporal Dynamics"

Period of grant: September 1, 1991 - August 31, 1995

Principal Investigator: R.A. Houghton

(NASA-CR-199232) THE ROLE OF
TROPICAL DEFORESTATION IN THE
GLOBAL CARBON CYCLE: SPATIAL AND
TEMPORAL DYNAMICS Final Technical
Report, 1 Sep. 1991 - 31 Aug. 1995
(Woods Hole Research Center) 4 p

N96-13394

Unclass

G3/45 0064179

"The Role of Tropical Deforestation in the Global Carbon Cycle: Spatial and Temporal Dynamics", was a joint project involving the University of New Hampshire (David Skole and Berrien Moore), the Marine Biological Laboratory (Jerry Melillo and Paul Steudler), and the Woods Hole Research Center (R.A. Houghton). The contribution of the Woods Hole Research Center consisted of three tasks:

1. assist David Skole at the University of New Hampshire in determining the net flux of carbon between the Brazilian Amazon and the atmosphere by means of a terrestrial carbon model;
2. address the spatial distribution of biomass across the Amazon Basin, and
3. assist NASA Headquarters in development of a science plan for the Terrestrial Ecology component of the NASA-Brazilian field campaign (anticipated for 1997-2001).

Progress on these three tasks is briefly described below.

1. Computation of the net flux of carbon between the Brazilian Amazon and the atmosphere

Calculation of the net flux of carbon between terrestrial ecosystems and the atmosphere requires data on rates of land-use change and on the standing stocks of carbon in undisturbed and changed ecosystems. Prior to this research, the greatest uncertainty in estimates of terrestrial carbon flux resulted from the large variation in estimates of deforestation (greater than a factor of four for the Brazilian Amazon). Skole and Tucker (1992), as part of this work but with support from NASA's Landsat Pathfinder Program, determined the rate of deforestation for the humid forests of the Brazilian Amazon to have averaged 1.8×10^6 /yr for the period 1978-1988. This new estimate was at the low end of previous estimates.

Using this average rate of deforestation with estimates of biomass (derived from this work; see below) and soil carbon (Moraes et al. 1995), we made a preliminary calculation of the net flux of carbon for the humid forests of the Amazon: a net release of 0.1 PgC/yr. This estimate is lower than previous estimates because both the rate of deforestation and the estimate of biomass (see below) were lower than earlier studies had determined, and because the area of secondary forests (presumably regrowing and acting as a sink for carbon) was greater than expected. The estimate of flux is preliminary. Especially important is the rate of regrowth and fate of secondary forests. Some are cleared again after only a few years.

2. The spatial distribution of biomass across the Amazon Basin

Biomass was calculated in this work from the more than 2000 plots sampled by the RADAMBRASIL project (1972-1984). Measured wood volumes (m^3) were converted to total carbon stocks (above- and below-ground live biomass), using equations developed by Brown et al. (1989), and extrapolated over the Brazilian Amazon on a GIS at the University of New Hampshire. Total above-ground biomass was found to be 61 PgC for the humid forests of the Basin, yielding an average biomass of 144 MgC/ha.

The accuracy of these preliminary estimates of biomass is not known at present. Future work should involve at least three components:

- a. Checking the RADAMBRASIL data on wood volume against independent field measurements of volume and biomass obtained at the same locations.
- b. Improvement in estimates of total biomass by adding standing, fallen, and below-ground dead biomass to current estimates of above-ground live vegetation, and by measuring below-ground biomass at several more sites.
- c. Exploration of alternative methods for extrapolating point measurements of biomass over the entire Amazon Basin. Over very large areas biomass is probably best predicted from climatic variables. Within climatic zones, differences in soil properties (for example, fertility and drainage) are important. And finally, superimposed over the undisturbed biomass predicted from these environmental variables is the actual biomass resulting from both natural and human disturbances. Because disturbances are frequent and not always observable with Landsat data, and because biomass is a dynamic property, always changing, the need for direct determination of above-ground biomass with satellite remote sensing seems critical. Such a system would have worldwide application in a country-by-country inventory of emissions for the UN Framework Convention on Climate Change.

3. Assist in the development of a science plan for the Terrestrial Ecology component of the NASA-Brazilian field campaign (anticipated for 1997-2001)

Two 1-year, no-cost extensions were granted to this project, first, so that the principal investigator could spend a year as a Visiting Senior Scientist at NASA Headquarters, and, second, so that he could attend several NASA-sponsored meetings and prepare a white paper to help develop a science plan for the Terrestrial Ecology component of a major NASA-Brazilian campaign in the Amazon. A modified version of the white paper is forthcoming (Houghton, in press).

References

- Brown, S., A.J.R. Gillespie, and A.E. Lugo. 1989. Biomass estimation methods for tropical forests with applications to forest inventory data. *Forest Science* 35:881-902.
- Houghton, R.A. In press. Carbon balance in Brazilian Amazonia. *Ciencia e Cultura*.
- Moraes, J.L., C.C. Cerri, J.M. Melillo, D. Kicklighter, C. Neill, D.L. Skole, and P.A. Steudler. 1995. Soil carbon stocks of the Brazilian Amazon Basin. *Soil Science Society of America Journal* 59:244-247.
- Skole, D.L., and C.J. Tucker. 1993. Tropical deforestation and habitat fragmentation in the Amazon: satellite data from 1978 to 1988. *Science* 260:1905-1910.